What is claimed is:

1.   A patient positioning assembly for adjusting patient position during therapeutic radiation treatment, said patient positioning assembly comprising:

a.   a support device for supporting the patient during treatment; and

b.   a controller for controlling the motion of said support device, said controller comprising:

  i)   means for receiving pre-treatment scan data representative of one or more pre-treatment scans of a treatment target within the patient, the pre-treatment scans showing the position and orientation of said target with respect to a pre-treatment coordinate system;

  ii)   means for activating an imaging system so that said imaging system generates image data representative of at least one near real time image of said target, said image data containing information regarding the near real time position and orientation of said target with respect to a treatment coordinate system, said treatment coordinate system having a predetermined relationship to said pre-treatment coordinate system; and

  iii)   means, responsive to said pre-treatment scan data and said image data, for generating at least one motion command signal for implementing one or more corrective motions of said support device, said corrective motions of said support device aligning said target with respect to said treatment apparatus so that the position and orientation of said target, as shown in said near real-time image data of said target, substantially match the position and orientation of said target as shown in said pre-treatment scan data of said target.

2.   A patient positioning assembly in accordance with claim 1, wherein said controller includes user interface means for enabling the user to interactively control said corrective motions of the support device, by implementing one or more user-selectable functions.

3. A patient positioning assembly for aligning a target within a patient's anatomy with respect to a radiosurgical treatment apparatus, said radiosurgical treatment apparatus including a treatment beam generator and an imaging system for generating one or more images of said target in near real time, said patient positioning assembly comprising:

a. a support device for supporting the patient during treatment;

b. at least one sensor for sensing the position and orientation of said support device, and for generating at least one sensor signal representative thereof;

c. a controller for controlling the motion of said support device in order to align said target with respect to said treatment beam generator, said controller comprising:

 i) means for receiving pre-treatment scan data representative of pre-treatment scans of the target that show the position and orientation of said target with respect to a pre-treatment coordinate system;

 ii) means for activating an imaging system so that said imaging system generates image data representative of at least one near real time image of said target, said image data containing information regarding the near real time position and orientation of said target with respect to a treatment coordinate system, said treatment coordinate system having a predetermined relationship to said pre-treatment coordinate system;

 iii) means, responsive to said at least one sensor signal, said pre-treatment scan data, and said image data, for generating at least one motion command signal for implementing one or more corrective motions of said support device, said corrective motions of said support device aligning said target so that the position and orientation of said target, as shown in said near real-time image data of said target, substantially match the position and orientation of said target as shown in said pre-treatment scan data of said target;

and

d. at least one actuator for moving said support device in accordance with said motion command signal from said controller.

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4.   A patient positioning assembly in accordance with claim 3, wherein said controller comprises user interface means for enabling the user to interactively control the motion of the support device by implementing one or more user-selectable functions.

5.   A patient positioning assembly in accordance with claim 4, further comprising a support device interface module for enabling said support device to interface with said sensor, said controller, said actuator, and said user interface means.

6.   A patient positioning assembly in accordance with claim 5, wherein said support device interface module includes:

a)   means for communicating with said sensor, so as to receive from said sensor said sensor signal;

b)   means for communicating with said controller, so as to provide position feedback to said controller in accordance with said sensor signal, and so as to receive said motion command signal from said controller; and

c)   means for communicating with said actuator so as to transmit said motion command signal from said remote controller onto said actuator.

7.   A patient positioning assembly in accordance with claim 3, wherein said one or more corrective motions of said support device have at least three degrees of freedom.

8.   A patient positioning assembly in accordance with claim 3, wherein said one or more corrective motions of said support device have at least five degrees of freedom.

9.   A patient positioning assembly in accordance with claim 8, wherein said five degrees freedom comprise three translational degrees of freedom for translations along mutually orthogonal x-, y-, and z- coordinate axes, and two rotational degrees of freedom for roll- and pitch- rotations around roll- and pitch- axes, respectively.

10. A patient positioning assembly in accordance with claim 8, wherein said controller further comprises software for converting said information regarding near real time target location and orientation into one or more units of motion of said support device in at least one of said five degrees of freedom.

11. A patient positioning assembly in accordance with claim 8, further comprising an external device for correcting for a sixth degree of freedom of said corrective motion of said support device, wherein said sixth degree of freedom is a rotational degree of freedom for yaw-rotation about a yaw-axis.

12. A patient positioning assembly in accordance with claim 8, wherein said external device comprises a robot.

13. A patient positioning assembly in accordance with claim 3, wherein said controller further comprises means for detecting, reporting, and correcting one or more errors.

14. A patient positioning assembly in accordance with claim 13, wherein said one or more errors comprise at least one of:
a) a communication error between said controller and one of said sensor, said support device, and said actuator;
b) an error in said information regarding target position and orientation;
c) an error in one or more of said corrective motions; and
d) an interface error between said support device and at least one of said sensor, said controller, and said actuator.

15. A patient positioning assembly in accordance with claim 13, wherein said means for correcting one or more errors comprises at least one of:
a. means for deactivating said imaging system so as to prevent any further images from being acquired;

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b.   means for preventing any further corrective motion of said supporting device;

c.   lockout means for turning off, during the error correction process, any and all radiation and motion from any and all components of said treatment apparatus.

16.   A patient positioning assembly in accordance with claim 3, wherein said support device comprises a table.

17.   A patient positioning assembly in accordance with claim 4, wherein said user interface means comprises a remote control module that provides a user with remote control capabilities for remote control of the motion of said support device.

18.   A patient positioning assembly in accordance with claim 17, wherein said remote control module comprises a handheld pendant.

19.   A patient positioning assembly in accordance with claim 3, wherein said controller has pre-programmed therein at least a first and a second position of said support device.

20.   A patient positioning assembly in accordance with claim 19, wherein said first pre-programmed position of said support device corresponds to a mounting position for facilitating the mounting of said patient onto said support device.

21.   A patient positioning assembly in accordance with claim 19, wherein said second pre-programmed position of said support device corresponds to a nominal treatment position in which said patient was treated at a time period prior to the current treatment.

22.   A patient positioning assembly in accordance with claim 3, wherein said pre-treatment scan data comprise 3D scan data.

23.   A patient positioning assembly in accordance with claim 3, wherein said pre-treatment scan data comprise at least one of: CT scan data, PET scan data, MRI scan data, and ultrasound scan data.

24.   A patient positioning assembly in accordance with claim 4, wherein said user interface means comprises one or more button icons respectively associated with said one or more user selectable functions, and wherein said user selectable functions comprise at least one of:

a.   a function for allowing the user to activate said imaging system so as to initiate the acquisition of one or more near real time images of said target;

b.   a function for allowing the user to move the support device to at least one of:

    i)   a first pre-programmed position corresponding to a mounting position for facilitating the mounting of said patient onto said support device;

    ii)   a second pre-programmed position corresponding to a nominal treatment position;

c.   a function for displaying to the user a sequence of translations and rotations corresponding to said one or more corrective motions implemented by said motion command signal;

and

d.   a function for allowing the user to modify said sequence of translations and rotations.

25.   A patient positioning assembly in accordance with claim 24, wherein said user selectable functions further comprise:

    i)   a function for allowing the user to compare said translations and rotations with respective pre-specified limits for each translation and rotation;

    ii)   a function for allowing the user to modify one or more of said pre-specified limits; and

iii)   a function for allowing the user to activate said treatment beam generator to initiate treatment delivery, upon verification that said translations and rotations identified by said motion command signal fall below said pre-specified limits.

26.   A patient positioning assembly in accordance with claim 24, wherein said sequence of translations and rotations encompass up to six degrees of freedom.

27.   A patient positioning assembly in accordance with claim 4, wherein said user interface means comprises at least one user interface screen.

28.   A patient positioning assembly in accordance with claim 27, wherein said user interface screen comprises means for allowing the user to adjust one or more imaging parameters of said imaging system.

29.   A patient positioning assembly in accordance with claim 28, wherein said imaging parameters comprise at least one of:
   a)   an intensity of the x-rays in one or more imaging beams generated by said imaging system;
   b)   a spectral distribution of said x-rays in said imaging beams;
   c)   the energy of x-rays in imaging beam;
   d)   the selection and de-selection of fiducials;
   e)   one or more rigid body parameters; and
   f)   the number of near real-time images to be acquired.

30.   A patient positioning assembly for aligning a target within a patient's anatomy with respect to a radiosurgical treatment apparatus, said patient positioning assembly comprising:
A.   a support device for supporting the patient during treatment; and

B.   a controller for controlling the motion of said support device so that said target becomes properly aligned with respect to said radiosurgical treatment apparatus, said controller comprising:

a)   means for receiving pre-treatment scan data representative of one or more pre-treatment scans of a treatment target within the patient, the pre-treatment scans showing the position and orientation of said target with respect to a pre-treatment coordinate system;

i)   pre-treatment scan data representative of pre-treatment scans of the target showing the position and orientation of said target with respect to a pre-treatment coordinate system; and

ii)   near real time image data containing information regarding the near real time position and orientation of said target with respect to a treatment coordinate system, said treatment coordinate system having a predetermined relationship to said pre-treatment coordinate system;

b)   means for comparing the position and orientation of said target, as shown in said near real-time image data, with the position and orientation of said target as shown in said pre-treatment scan data; and

c)   means for generating at least one motion command signal for implementing one or more corrective motions of said support device, said corrective motions aligning said target with respect to said treatment apparatus in such a way that the position and orientation of said target, as shown in said near real-time image data of said target, substantially match the position and orientation of said target as shown in said pre-treatment scan data of said target; and

d)   user interface means for enabling the user to interactively participate in controlling the motion of the support device, by implementing one or more user-selectable functions.

31.   A patient positioning assembly for aligning a target within a patient's anatomy with respect to a radiosurgical treatment apparatus, said patient positioning assembly comprising:

A.   a support device for supporting the patient during treatment; and

B.   a controller for controlling the motion of said support device so that said target becomes properly aligned with respect to said radiosurgical treatment apparatus, said controller comprising:

a)   an input module for receiving:

    i)   pre-treatment scan data representative of pre-treatment scans of the target showing the position and orientation of said target with respect to a pre-treatment coordinate system; and

    ii)   near real time image data containing information regarding the near real time position and orientation of said target with respect to a treatment coordinate system, said treatment coordinate system having a predetermined relationship to said pre-treatment coordinate system;

b)   a comparator for comparing the position and orientation of said target, as shown in said near real-time image data, with the position and orientation of said target as shown in said pre-treatment scan data; and

c)   a signal generator coupled to said comparator for generating at least one motion command signal for implementing one or more corrective motions of said support device, said corrective motions aligning said target with respect to said treatment apparatus in such a way that the position and orientation of said target, as shown in said near real-time image data of said target, substantially match the position and orientation of said target as shown in said pre-treatment scan data of said target; and

d)   user interface means for enabling the user to interact in controlling of the motion of the support device, by implementing one or more user-selectable functions.

32.   A radiosurgical treatment apparatus for treating a target in a patient, comprising:

a.   an imaging system for generating image data representative of one or more near real time images of said target, said image data containing information regarding the near real time position and orientation of said target with respect to a treatment coordinate system;

b.   a robot including an articulated arm assembly;

c.   an x-ray source mounted at a distal end of said arm assembly and adapted for selectively emitting an x-ray beam;

d.   a support device for supporting the patient during treatment; and

e.   a controller for controlling the relative motion of said support device with respect to the motion of said x-ray source, said controller comprising:

i)   means for receiving pre-treatment scan data representative of one or more pre-treatment scans of said target showing the position and orientation of said target with respect to a pre-treatment coordinate system, said pre-treatment coordinate system having a predetermined relationship to said treatment coordinate system;

ii)   means for receiving said image data; and

iii)   means, responsive to said pre-treatment scan data and said image data, for generating at least one motion command signal for implementing one or more corrective motions of said support device, wherein said corrective motions of said support device allow the position and orientation of said target, as shown in said near real-time image data of said target, to substantially match the position and orientation of said target as shown in said pre-treatment scan data of said target.

33.   A radiosurgical treatment apparatus in accordance with claim 32, wherein said controller further comprises user interface means for enabling the user to interactively control the motion of the support device by implementing one or more user-selectable functions.

34.   A radiosurgical treatment apparatus in accordance with claim 32, wherein said corrective motions of said support device, implemented by said motion command signal generated by said controller, compensate for one or more motions of said x-ray source implemented by said robot,

so that said corrective motions of said support device, in combination with said motions of said x-ray source, cause a desired x-ray radiation pattern to be delivered to said target throughout treatment.

35. A radiosurgical treatment apparatus in accordance with claim 32, wherein said corrective motions of said support device, implemented by said motion command signal generated by said controller, compensate for one or more motions of said x-ray source implemented by said robot, in a way as to maximize the workspace available to said treatment apparatus.

36. A radiosurgical treatment apparatus in accordance with claim 32, wherein said corrective motions of said support device, implemented by said motion command signal generated by said controller, compensate for one or more patient motions of said patient that take place during treatment.

37. A radiosurgical treatment apparatus in accordance with claim 36, wherein said one or more patient motions comprise at least one of:
a. a respiratory motion of said patient;
b. a muscular shifting of one or more members of said patient;
c. motion caused by one of sneezing, coughing, and hiccuping of said patient; and
d. cardiac pumping motion of the heart of the patient.

38. A patient positioning assembly for aligning a target within a patient's anatomy with respect to a radiosurgical treatment apparatus, said radiosurgical treatment apparatus including a treatment beam generator and an imaging system for generating one or more images of said target in near real time, said patient positioning assembly comprising:
a. a support device for supporting the patient during treatment;
b. at least one sensor for sensing the position and orientation of said support device, and for generating at least one sensor signal representative thereof;

c.   a controller for controlling at least the motion of said support device in order to align said target with respect to said treatment beam generator, said controller comprising:

      i)   means for receiving pre-treatment scan data representative of pre-treatment scans of the target that show the position and orientation of said target with respect to a pre-treatment coordinate system;

      ii)   means for activating an imaging system so that said imaging system generates image data representative of at least one near real time image of said target, said image data containing information regarding the near real time position and orientation of said target with respect to a treatment coordinate system, said treatment coordinate system having a predetermined relationship to said pre-treatment coordinate system;

      iii)   means, responsive to said at least one sensor signal, said pre-treatment scan data, and said image data, for generating at least one motion command signal for implementing one or more corrective motions of said support device, said corrective motions of said support device aligning said target so that the position and orientation of said target, as shown in said near real-time image data of said target, substantially match the position and orientation of said target as shown in said pre-treatment scan data of said target, said corrective motions having up to six degrees of freedom;

d.   at least one actuator for moving said support device in accordance with said motion command signal from said controller; and

e.   an external device for correcting up to six degrees of freedom of the motion of said support device.